driver, which acts upon projections on the plug of the cock, and also carries a metal cylinder hermetically sealed, in which is a heavy ball, less in diameter than the cylinder itself, so that it may freely roll within it. In the upper part of one of the chambers is a float working upon an axis, which carries a pendent arm, having upon its end a friction-pulley.

As the float rises and falls by the action of the water, the arm vibrates, and, acting alternately on the inner sides of two teeth of the spindle, causes the lower end of the cylinder to be raised, and thus the ball rolls to the opposite end of the cylinder, which by its weight moves the spindle suddenly round, and causes a change of inlet and outlet by the motion communicated to the plug of the cock; upon the axis are two teeth working into a crown-wheel, so that the vibrations of the axis give rotary motion to the upright spindle, which is connected with a counting apparatus, also of an improved description.

No. XXV.

WRIGHT'S IMPROVED BAROMETER.

The barometer as commonly constructed is liable to three sources of error, viz. first, from the ever-varying level of the mercury in the cistern, which receives a certain portion of liquid from the tube at every diminution of, or addition to, pressure; secondly, from capillary attraction, the effect of which is to depress the column below its true level, in proportion to the diameter of the tube and the length of the column; and, thirdly, from the variation in the density of the mercury caused by the change of temperature.

The mode of correcting such errors is by means of certain formulæ, which it would be irrelevant now to enter upon, but which may be found in "Turner's Elements of Chemistry," and other works of the kind; most minute directions and tables for their correction may also be found in a pamphlet published by the Royal Society for the encouragement of more correct meteorological observations.

To those who are not aware of the importance of the slightest error in this instrument, it will only be necessary to mention that mercury is in this instance employed to measure the density of a fluid which is about 11,058 times lighter than itself, and that a column of thirty inches of mercury may be supposed to stand in the opposite balance to a column of forty miles of air.

It is not surprising that many attempts have been made to render this instrument accurate in its action, since it would give truth to the observations of those who neglected the errors, and save much time and calculation to those who were in the habit of rectifying them. I am not aware that any of them have been successful; none of them, however, have come into general use, and we are therefore led to infer their practical failure.

The instrument I am about to describe is similar to the pediment barometer in its arrangement, consisting of a straight inverted tube, with the cistern at bottom and the scale and vernier at top, the improvements consisting in the relative areas of the tube and cistern, a certain departure from what may be termed accurate measurement in the scale, the inches being less than inches, and the tenths less than tenths, and also in the tenth lines being arranged angularly instead of horizontally.

First, with regard to the variation of the level of the

cistern. If the atmospheric pressure be equal to 30 inches, the common barometer will be correct in its indications, for, at that point, it is exactly 30 inches from the level of the mercury in the cistern to the top of the column; if the column falls 1 inch, the indication will then be 29 inches. This, however, is not correct, for the 1 inch of mercury which fell from the tube will have raised the mercury in the cistern in proportion to their relative areas. Thus, if they were equal in area, the mercury in the cistern would have risen just as much as that in the tube had fallen, and the true indication would be 28 inches; if the tube were $\frac{1}{100}$ of the area of the cistern, the true indication would be 28 inches and $\frac{99}{100}$, being 1 inch and $\frac{1}{100}$ of a fall, instead of 1 inch as indicated. To remedy this error, it is customary to make the tubes of barometers very small, and thereby to increase the difference between the areas of the tube and cistern, and render this error less in amount. This does not, however, altogether do away with it, for if the cistern were as large as the ocean, and the tube as fine as a needle, it could still be demonstrated that a fall of the one would cause a rise in the other; besides this, it entails upon the instrument another evil, the great increase of capillary attraction, and, consequently, a less delicate action.

In instruments which are used in meteorological observations, this error is corrected by means of a sliding-rod attached to the scale, having a pointer at bottom which is brought in contact with the surface of the mercury in the cistern, at every observation, by means of a rack and pinion; the scale is thereby raised and lowered as much as the mercury rises or falls.

The method which I have adopted is to make the

area of the cistern exactly 50 times larger than the area of the tube; and as it is evident that a fall of 1 inch in the tube will give a rise of $\frac{1}{50}$ of an inch in the cistern, I have shewn each inch on the scale $\frac{1}{50}$ less than an inch, and each tenth $\frac{1}{50}$ less than a tenth; so that if the column falls $\frac{49}{50}$ of an inch, the cistern will be raised $\frac{1}{50}$, making 1 inch; the upper and under levels have thereby approached each other, which will be indicated on the scale. By these means a large tube may be used, and a sliding-scale dispensed with, and, I believe, a more accurate result obtained by one observation than by two (which is the case when the gauge-point is used); for I cannot suppose the human eye capable of distinguishing much less than $\frac{1}{1000}$ of an inch, whereas calculation may be said to be correct to infinity.

The next improvement is with respect to capillary attraction. It is, perhaps, necessary to premise that, according to the diameter of the tube, a certain amount of attraction is exercised upon the mercury, the effect of which is to depress it. This attraction is greater in the small tube than in the large one, and also increases in proportion to the length of the column; it is, likewise, greater in the unboiled than in the boiled tubes, being rather more than double. Thus, a column of $\frac{6}{10}$ of an inch in diameter, and 30 inches long, *boiled*, would suffer a depression of $\frac{62}{1000}$ of an inch, while a column of $\frac{1}{10}$ of an inch in diameter, the same length, and also boiled, would suffer a depression of $\frac{210}{1000}$ of an inch: either of the aforesaid columns, if one-half the length, would be depressed only one half as much, or, if unboiled, would be depressed rather more than double.

There are no means of correcting this error in ordinary barometers; those, however, which are used for meteorolo-

gical purposes have the diameters of the tube engraved upon them, and are corrected by calculation or by reference to tables. I have again, in this instance, resorted to the expedient already referred to in the correction from the variation of the cistern-levels, by deducting as much from each inch in the scale as the column is depressed by the force of capillary attraction, thereby rendering it self-corrected for this error, merely by means of the original measurement of the scale.

The barometer is now correct in its indications so long as the temperature remains at 32° of Fahrenheit. Any increase to or decrease from this point alters the density of the column, and as columns of equal lengths and different densities give different pressures, so this gives rise to another error, which is corrected by a calculation, based upon the known expansion of mercury.

I will endeavour to explain the means I have employed to accomplish this object. It has been found, by accurate experiments, that mercury expands for every degree of Farh. thermometer, $\frac{1}{9990}$ part of its volume at 32°; now the expansion of a column 30 inches long, from 32° to 100°, will, at this rate, amount to ·205 inch. I think it will be evident that, if the horizontal line which stands opposite 30 inches in the scale of the ordinary barometer, be raised ·205 inch at one end, it will form an angular line representing the expansion of a column of mercury, 30 inches long, from 32° to 100°, the lower point being that at 32°, and the upper that at 100°. And if this line be divided into 68 parts, or intersecting lines, that being the number of degrees between 32° and 100°, such lines will shew the expansion of a 30-inch column for all the degrees between 32° and 100°. This angular line is, therefore, transferred to the scale,

and all the other inches and tenths are calculated in the same manner, those above giving a greater, and those below a lesser angle. Thus the expansion of a 31-inch column, from 32° to 100°, amounts to ·211 inch, and a 27-inch column to ·184 inch. I have not, however, intersected the angular lines on the scale with 68 lines, but (what will answer the same purpose in a more simple manner) divided the top of the vernier into 68 parts or lines, corresponding to the various degrees. In taking observations it is necessary that the degree on the vernier which the thermometer indicates at the time should be made to impinge upon that angular line, either at or immediately below the top of the barometric column. This will give the height in inches and tenths of inches. If the column is a little above, there is a small dial and pointer in the centre of the vernier, which, on being raised upwards, gives the hundredths and thousandths, thereby giving the height corrected for temperature without calculation.

It gives me pleasure to state that, in this last improvement connected with the temperature, I have been assisted by Mr. John Clarke, now in the office of Messrs. Newton and Sons, of Chancery Lane.

There are several minute matters in this calculation which I have entirely left out for the sake of rendering it more intelligible. I have had the barometer in action for nearly twelve months, and have frequently corrected its indications by calculation, and found it answer excellently. Indeed, as the tube and cistern are exactly similar to those in common use, it is not liable to any contingency which is not common to all. It can be made at a price less than the standard barometers of the best kind; and, judging from the desire of the Admiralty to ensure

greater accuracy on the part of masters of ships in their observations, I conceive it would be to them of some service, as well as to scientific men in general.

No. XXVI.

ON RENDERING PAPER-HANGINGS USEFUL AS WELL AS ORNAMENTAL.

By the Secretary.

Paper-hangings are of several kinds, some of which are made in imitation of velvet, damask, chintzes, &c., while others are in imitation of marbles, stucco-work, &c.

There are three methods by which paper-hangings are painted. The first by printing on the colours, the second by means of the stencil, and the third by using the pencil as in other kinds of painting.

In the first method the impression is made by wooden blocks, in which the patterns are cut, the parts to be shewn being made to project from the surface by cutting away all the other parts. The blocks being charged with the required colour, properly tempered, are pressed on the paper prepared with a proper ground of colour or varnish.

The colour to be used by the printer is spread on oil-cloth, laid on a flat block a little larger than the print; this operation is performed by an attendant, who spreads the colour with a brush on the block, between every stroke and impression made by the printer.

When the sheet is printed throughout, it is hung up to dry, and the operation is repeated with another piece of paper.